

Potassium Interactions and Balanced Plant Nutrition

By N.R. Usherwood

Potassium (K) is well known for its role in balanced plant nutrition. But, is it well understood? Probably not. A review of the research-based reasons might be helpful when making decisions regarding K fertilizer use.

BALANCED NUTRITION of plants should be a high priority management objective for every grower. This holds for nursery and ornamental plants just as much as it does for fruit trees or the feed and fiber crops. Nutrition is just as vital for a plant as it is for a high producing dairy cow. Both require a balanced nutrition program formulated to provide specific needs for maintenance and for expected production performance. Properly nourished plants and animals grow stronger, produce more consistently, have better disease resistance, and are more tolerant to stress.

Potassium requirements for a balanced nutrition program can be crop, site and management specific. Thus, to obtain the optimum return from this investment, it helps to understand the benefits from proper supply as well as the problems associated with a shortage. To provide plant K needs, then, the nutrient reservoir must be monitored frequently by soil testing and resupplied from fertilizer sources. The objective is clear but challenging. It is to eliminate nutrient shortage as a condition which limits the development of a plant's full genetic potential.

What Is Potassium's Role?

Potassium is a "work horse" plant nutrient. Perhaps this is because it is not bound into any specific plant compound. Therefore, K is free to travel and to wheel and deal within the plant almost at will. Since K is directly or indirectly involved

in most plant processes, it should not be surprising that K nutrition is closely tied to each of the following important crop functions. These are reasons why a shortage of K can result in lost crop yield, quality and profitability.

- **Regulation of enzyme systems . . .** K is known to influence more than 60 enzyme reactions. Thus, K is associated with almost every major plant function
- **Photosynthesis . . .** K regulates the carbon dioxide supply by control of the opening of leaf pores (stomates)
- **Respiration . . .** K improves the efficiency of plant use of sugars for maintenance and normal growth functions
- **Translocation . . .** K moves sugars from sites of photosynthesis to cotton bolls or other storage depots
- **Root development . . .** K works with phosphorus to stimulate and maintain rapid root growth of seedling plants
- **Legume nodulation . . .** K is needed for optimum nodule formation and efficient fixation of N by legume plants
- **Winter hardiness . . .** K serves as an "anti-freeze" by lowering the freezing point of the cell sap in roots and by building plant tolerance to low temperature stress
- **Protein synthesis . . .** K stimulates the synthesis of true protein in plants from the amino acid building blocks

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- **Disease resistance** . . . K improves plant health and natural resistance to many leaf, root and shoot diseases
- **Insect tolerance** . . . K-healthy plants better tolerate pests and often recover more quickly from root and shoot injury inflicted by nematodes and insects.

Potassium Strengthens Crop Use of Other Inputs

Potassium's involvement in so many functions is the very reason why it is a vital part of any balanced nutrition program. It improves the use of nitrogen (N) and other inputs which are also responsible for developing a plant's genetic potential into reality at harvest time. Following are a few examples which illustrate how N and K share responsibilities.

Converting into amino acids and proteins. Too much N or too little K can result in a back-up of the protein building blocks. These can increase susceptibility to diseases on crops like corn. An imbalance can also lower the quality of forage crops or it can reduce use efficiency of N and K by others.

Improving crop disease resistance. Nitrogen teamed with too little K sets the stage for disease problems like *Fusarium* stalk rot in corn or some of the leaf rust problems on wheat and other small grains. In Kansas, for example, potassium chloride (KCl) improved wheat tolerance to disease and that helped to boost grain yield by nearly 10 bu/A.

Improving fruit development and quality. Potassium is needed for the production of carbohydrates and for proper balance of these with N for best fruiting. The symptoms of a shortage are poorly filled grain on the tip end of an ear of corn, dropped fruit under an orange tree, low test-weight in small grains, or perhaps dockage due to shriveled and diseased soybean seeds.

Regulating photosynthesis. A shortage of K keeps plant leaf pores from opening properly and restricts the flow of air and

carbon dioxide into the leaf. This slows photosynthesis and the production of sugars. Nitrogen, in the meantime, is also helping to regulate this process.

Interacting Nutrients Have Many Plant Functions in Common

Potassium and 15 other nutrients are equally essential for plant growth. How K interacts with each nutrient is best illustrated by the number of crop functions they have in common. Such interactions are the reasons why nutrient balance is so important. The following are examples.

Phosphorus and potassium

- root development
- photosynthesis
- regulation of enzymes
- seed formation
- crop maturity
- energy transfer
- crop winter hardiness

Sulfur and potassium

- photosynthesis
- winter hardiness
- nitrogen fixation
- chlorophyll formation
- enzyme system and vitamin development
- amino acids and protein formation

Magnesium and potassium

- photosynthesis
- chlorophyll formation
- plant respiration
- seed formation
- enzyme systems
- phosphate metabolism
- forage quality
- sugar and nutrient transport

Calcium and potassium

- enzyme systems
- fruit quality
- cell walls and plant structure
- nitrate reduction during protein formation
- needed by *Rhizobium* and for N fixation

Micronutrients and potassium

- nitrogen metabolism and fixation (molybdenum, manganese)

- chlorophyll formation (iron, zinc, manganese)
- enzyme systems (zinc, molybdenum, manganese, iron, copper)
- cell development (boron, iron)
- respiration (copper)

How Can These Interactions Be Harnessed?

Consider the following guidelines for building plant nutrition facts into existing farm management systems.

Use available knowledge. It is important to know what each nutrient is capable of doing for the crop and to recognize when it is in short supply. Unexpected plant growing conditions can restrict crop use of the soil nutrient supply. Early recognition of a nutrient shortage often allows in-season adjustments.

Establish a quality soil analysis program. This best management practice (BMP) is a good starting point. Sampling is critical, but so is recent, optimum-yield, specific-crop correlation information. Remember, a highly productive soil must also be highly fertile.

Obtain total crop nutrient requirement facts. These data are most helpful when they also indicate nutrient need by growth stage, by yield level, and for special market quality requirements. These data can also be used with the soil test results when establishing fertilizer needs.

Consider special soil, climate, and management conditions. These are equally important in establishing crop nutrient needs. Consider nutrient leaching loss from sandy soils, risk of low temperature crop injury, use of manure, availability of irrigation, or use of foliar fertilization.

Coordinate nutrient management with tillage practices. Reduced tillage can

change surface soil characteristics which influence root growth and nutrient management. For example, an increase in crop residue on the soil surface can lower soil temperature, increase the soil moisture level, and result in a build-up of P and soil acidity near the soil surface.

Time fertilizer applications with crop need. Time, rate and method of application of plant nutrients are crop and site specific. Computers now allow precision and prescription fertilization programs to be developed. They provide the capability for considering more of the variables, such as nutrient interactions, which influence plant nutrition and fertilizer use.

Maintain an environmental awareness. Top farmers are skilled managers of inputs needed for optimum crop yield, quality, profitability and protection of the soil and water resources. Practices which eliminate soil erosion also prevent fertilizer P from getting into surface waters. By using BMPs and developing a balanced nutrition program, most problems with N loss can be avoided.

Properly utilized, fertilizer protects the soil from erosion and improves groundwater quality by improving rapid seedling development, early vegetative cover of the soil, and optimum production of roots and shoots which become soil protecting crop residue.

Turn challenges into opportunities. Today's challenges at the farm level require more attention to the details of doing business than ever before. Potassium's specific functions in plant development and its interactions with other nutrients and practices illustrate well its vital role in a truly sustainable agriculture. ■